Declaration

I, Fumio SATOU, a national of Japan, who works for Nitto International Patent Office P.P.C., 8th floor No. 17 Arai Building, 3-3, Shinkawa 1-chome, Chuo-ku, Tokyo 104-0033, Japan declare that to the best of my knowledge and belief the attached is a true translation made by me of the annexed document which is Japanese Patent Application No. 2002-292794, filed on October 4, 2002, and further declare that the contexts of the translation and the Japanese document are the same.

I hereby declare that all statements made by me of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Signed this 14th day of June, 2006

Fumio SATOU

(Document Name) Specification

(Title of the Invention)

Method of Bonding Metallic Members by Plastic-Flow Bonding and Plastic-Flow Bonded Body

(Claims)

Claim 1. In a bonding method for bonding a rotating disc as a bonding member and a rotating shaft as a member to be bonded that are used in a rotating device, the method comprising:

a first step for fitting the bonding member to the member to be bonded to effect preliminary plastic bonding by means of a preliminary bonding punch; and

a second step, after the first step of preliminary plastic bonding, for plastic bonding by generating a compression force in the vicinity of a fitted portion of the bonding member in the axial direction of the member to be bonded, thereby to effect plastic flow of part of the bonding member to fill a gap between the bonding member and the member to be bonded,

wherein the bonding member and the member to be bonded are integrated by fitting.

Claim 2. The bonding method according to claim 1, wherein the fitting of the bonding member and the member to be bonded is gap shrink fitting.

Claim 3. A bonding method for bonding a rotating disc as a bonding member onto a rotating shaft as a member to be bonded by fitting the bonding member to the member to be bonded to integrate them, which comprises:

positioning the member to be bonded by inserting the member into a fitting hole of the bonding member, having an inner diameter larger than an outer diameter of the member;

effecting preliminary plastic bonding in the vicinity of the fitted portion of the member to be bonded and the bonding member under such a load as to generate a stress enough to plastically deform the material of the bonding member;

pressurizing a portion in the vicinity of the fitted portion between the bonding member and the member to be bonded under such a load as to exceed an elasticity limit of the bonding member; and

effecting plastic flow of part of the material in the fitted portion that exceeds the elasticity limit into the gap between the bonding member and the member to be bonded by generating a compression force in the axial direction of the member to be bonded in the vicinity of the fitted portion of the bonding member.

Claim 4. The bonding method according to claim 1, wherein an annular groove in the fitted portion between the bonding member and the member to be bonded is formed.

Claim 5. The bonding method according to claim 4, wherein knurl is formed in the groove formed in the fitted portion between the bonding member and the member to be bonded.

Claim 6. A bonded body of a bonding member and a member to be bonded used for a rotating device comprising the bonding member for stacking discs and the member to be bonded as a rotating shaft, which bonded body is manufactured by steps:

a step for fitting the bonding member to the member to be bonded to effect preliminary plastic bonding by means of a preliminary bonding punch; and

a step, after the first step of preliminary plastic bonding, for plastic bonding by generating a compression force in the vicinity of a fitted portion of the bonding member in the axial direction of the member to be bonded, thereby to effect plastic flow of part of the bonding member to fill a gap between the bonding member and the member to be bonded,

wherein the bonding member and the member to be bonded are integrated by fitting.

Claim 7. The bonding method according to claim 6, wherein an annular groove in the fitted portion between the bonding member and the member to be bonded is formed.

Claim 8. The bonding method according to claim 7, wherein knurl is formed in the groove formed in the fitted portion between the bonding member and the member to be bonded.

Claim 9. A mechanical apparatus provided with a bonded body of a bonding member and a member to be bonded, which are used in a device for rotating the bonding member on which rotary disks are stacked and the member to-be-bonded serving as a rotary shaft in integral bonding:

wherein a portion, in the vicinity of the fitting portion of the member to-be-bonded, of the bonding member is pressed to provide a plastically deformed part, which is in the vicinity of the fitting portion of the member to-be-bonded and is further pressed, followed by plastic-flow bonding.

(Detailed Description of the Invention)

(0001)

(Technical Field to which the Invention Pertains)

The present invention relates to a method of bonding metallic members by plastic-flow bonding, and a bonded body obtained by the method.

(0002)

(Prior Art)

Conventional methods for fitting metallic members to each other and subjecting them by plastic-flow bonding

include a method for subjecting two members to plastic-flow bonding in a gap-shrink fitting state (for example, refer to Patent document 1).

(0003)

Furthermore, another method for fitting two metallic members to each other includes a method of subjecting them to plastic-flow bonding in a press-fitting state (for example, refer to Patent document 2).

(0004)

Japanese Patent Laid-open No. 11-120743 (page 4 and Figs. 3 and 4).

(0005)

Japanese Patent Laid-open No. 2001-54268, page 2 and Fig. 1).

(0006)

(Problems to be solved by thee invention)

In a bonding method disclosed in Patent document 1, since plastic-flow bonding is performed after metallic members are free-fitted with a gap to each other, a portion other than the vicinity of a portion which is pressed to effect plastic-flow forms a gap, as a matter of fact, which leads to relatively weak bonding strength, especially, bending strength. In particular, a problem will arise in the case where thin metal plate members are pressed to effect plastic-flow for bonding.

(0007)

In a bonding method disclosed in Patent document 2, since plastic-flow bonding is performed after two members are press-fitted to each other, there is no gap at a portion other than the vicinity of a portion which is pressed to effect plastic-flow, and therefore, high bonding strength, in particular, high bending strength can be achieved. However, a scrape or a gall tends to occur in the two members at the time of the press-fitting, thereby bringing about occurrence of bending due to the press-fitting or contamination. Moreover, high precision in shape of the bonding members is needed to manage a press-fitting margin, thereby increasing a cost.

(0008)

An object of the present invention is to provide a method of plastic flow bonding at low cost, with a high precision and a high bonding strength.

(0009)

(Means for solving the problems)

One of the features of the present invention in a bonding method for bonding a rotating disc as a bonding member and a rotating shaft as a member to be bonded that are used in a rotating device, the method comprising:

a first step for fitting the bonding member to the member to be bonded to effect preliminary plastic bonding

by means of a preliminary bonding punch; and

a second step, after the first step of preliminary plastic bonding, for plastic bonding by generating a compression force in the vicinity of a fitted portion of the bonding member in the axial direction of the member to be bonded, thereby to effect plastic flow of part of the bonding member to fill a gap between the bonding member and the member to be bonded,

wherein the bonding member and the member to be bonded are integrated by fitting.

(0010)

Another feature of the present invention resides in a bonded body of a bonding member and a member to be bonded used for a rotating device comprising the bonding member for stacking discs and the member to be bonded as a rotating shaft, which bonded body is manufactured by steps:

a step for fitting the bonding member to the member to be bonded to effect preliminary plastic bonding by means of a preliminary bonding punch; and

a step, after the first step of preliminary plastic bonding, for plastic bonding by generating a compression force in the vicinity of a fitted portion of the bonding member in the axial direction of the member to be bonded, thereby to effect plastic flow of part of the bonding member to fill a gap between the bonding member and the

member to be bonded,

wherein the bonding member and the member to be bonded are integrated by fitting.

(0011)

A still another feature of the present invention resides in A mechanical apparatus provided with a bonded body of a bonding member and a member to be bonded, which are used in a device for rotating the bonding member on which rotary disks are stacked and the member to-be-bonded serving as a rotary shaft in integral bonding:

wherein a portion, in the vicinity of the fitting portion of the member to-be-bonded, of the bonding member is pressed to provide a plastically deformed part, which is in the vicinity of the fitting portion of the member to-be-bonded and is further pressed, followed by plastic-flow bonding.

(0012)

(Embodiments for practicing the invention)

The present invention is applied to disc driving devices for computers, etc, spindle motors for DVD, CD-ROM, etc, thin type hard disc drive motors mounted on portable personal computers such as notebook type personal computers, wherein two members such as a shaft of a dynamic bearing structure of a spindle motor and a hub are plastic flow bonded. As an embodiment of the present invention, the

dynamic bearing spindle motor of a hard disc drive device using a bonded body of a hub and a shaft is described.

(0013)

Fig. 1 is a general plane view of a hard disk drive, and Fig. 2 is a cross-sectional view of the hard disk drive shown in Fig. 1.

In Figs. 1 and 2, reference numeral 200 designates a hard disk of a hard disc drive (abbreviated as "an HDD"), in which a dynamic pressure bearing spindle motor 100 is disposed. A read-out device 300 reads out data from a hard disk rotationally driven by the dynamic pressure bearing spindle motor 100.

(0014)

Fig. 3 shows a dynamic pressure-bearing spindle motor in the hard disk drive, in which a bonded body of a hub and a shaft is used, in a preferred embodiment according to the present invention.

(0015)

In Fig. 3, a shaft 1 is integrated with a hub 2 by a bonding method according to the present invention. To the hub 2 is securely fixed a magnet 13. A plurality of disks 3 serving as storage mediums are stacked on a flange 24 of the hub with disk spacers 4 held therebetween and are secured by a clamp 5 that is tightened to a female screw 32 of the shaft 1 with a screw 6. The shaft 1 is rotatably

fitted into the bore of a dynamic pressure bearing metal 8 secured to a housing 7. Thus, a radial dynamic pressure bearing is constituted by the effect of a dynamic pressure generated by a magnetic fluid filled inside the housing according to rotation. The housing 7 is fixedly secured to a base 11. A thrust receiving plate 10 is joined to the housing 7 while a stopper ring 12 is held between the dynamic pressure bearing metal 8 and the thrust receiving plate 10, and thus, constitutes a thrust bearing in which a spherical edge portion 40 of the shaft 1 is supported at a thrust receiving face 41. The shaft 1 is suppressed by the stopper ring 12 fitted into a stopper groove 42 from floating in a thrust direction. A wound stator core 14 is securely bonded to the base 11 with an adhesive, and therefore, the magnet 13 receives rotating force at the time of energization, thereby rotating the hub 2.

(0016)

Next, an explanation will below be made of the hub 2 and the shaft 1. It is desirable that the hub 2 as a bonding member should be made of a material which is liable to plastically deform and has deformation resistance is smaller than that of the shaft 1 serving as a member to be bonded. The hub 2 is made of ferrite stainless steel, for example, SUS430 in consideration of corrosion resistance and magnetic characteristics in terms of a motor. The

shaft 1 is formed into a columnar shape, and is made of martensitic stainless steel excellent in abrasion resistance or corrosion resistance such as SUS440 or SUS420 J2 in consideration of bearing performance, followed by hardening. At an outer diameter portion to be bonded in the vicinity of one end of the shaft 1 is formed an annular groove 31. The details of the shape of the groove will be described later.

(0017)

Fig. 4 shows a bonded body of the hub and the shaft in a preferred embodiment according to the present invention. In Fig. 4, the shaft 1 is provided with the annular groove 31 formed in the outer diameter portion to be bonded in the vicinity of one end of the shaft 1 and is plastically bonded to a bonding hole 21 formed in the hub 2 having a diameter greater than the outer diameter of the shaft 1 by a method, described below, as shown in Fig. 6. The shaft 1 and the hub 2 are bonded to each other through a first process in which the shaft 1 shown in Fig. 5 is freely fitted or gap-fitted to the hub 2 shown in Fig. 6, followed by preliminarily plastic bonding, and a second process of plastic-flow bonding.

(0018)

First, a description of the first process of the preliminarily plastic bonding will be given below. A bottom

face 23 of the hub 2 is held by a stand 63, as shown in Fig. 7. The hub 2 is held at an outer diameter 25 thereof by an inner diameter 62 of a guide ring 61. Thereafter, an edge portion 34 on a side on which the annular groove 31 is formed at the outer diameter portion to be bonded of the shaft 1 is inserted into and fitted to the bonding hole 21 of the hub 2.

(0019)

It is desirable from the viewpoint of bonding accuracy that a clearance or gap at the fitting portion between the shaft 1 and the hub 2 when the edge portion 34 of the shaft 1 is inserted into the bonding hole 21 of the hub 2, that is, a clearance between the wall surface of the bonding hole 21 of the hub 2 and the outer peripheral surface of the shaft 1 should be set as small as 0 to 0.02 mm. In the present preferred embodiment, the outer diameter of the shaft 1 is set to 3.00 mm while the inner diameter of the bonding hole 21 of the hub 2 is set to 3.01 mm.

(0020)

In this manner, while the bottom surface 23 of the hub 2 is held by the stand 63, the edge portion 34 of the shaft 1 is inserted into and fitted to the bonding hole 21 of the hub 2. Thus, a preliminarily bonding punch 60 is fitted to the inner circumference 65 of the guide ring 61 and the shaft 1 is fitted into a guide hole 64 formed at

substantially the center of the preliminarily bonding punch 60, thereby holding the shaft 1. The shaft 1 is held in the guide hole 64 of the preliminarily bonding punch 60 guided on the inner circumference 65 of the guide ring 61, and then, the preliminarily bonding punch 60 is driven by a press ram, not shown into the bonding member. When the preliminarily bonding punch 60 is driven by the press ram, a ring-like projection 66 having a projection width K is formed at the tip of the preliminarily bonding punch 60 by which an edge portion 22 of the hub 2 is pressed down in the vicinity of the bonding hole 21.

(0021)

The pressing force of the preliminarily bonding punch 60 is a load that generates stress large enough to plastic-deform the material forming the hub 2, and force that plastically deforms a portion corresponding to such a depth as to fill the fitting clearance between the shaft 1 and the hub 2 vertically. The preliminarily bonding punch 60 is pressed down at the above-described load, and then, the material in the vicinity of the bonding hole 21 of the hub 2 is allowed to plastic-flow, followed by the preliminary bonding. The bonding portion after the preliminarily plastic bonding in the above-described manner is shown in Fig. 8, which is an enlarged vertical cross-sectional view.

(0022)

Subsequently, an explanation will below be made of the second process of the plastic-flow bonding. In the second process shown in Fig. 9, a preliminary bonded body 80 of the shaft 1 and the hub 2 which have been subjected to the preliminarily plastic bonding is held by the stand 63 at the bottom face 23 of the hub 2, and the outer diameter 25 of the hub 2 is held by the inner diameter 62 of the guide ring 61. Then, the shaft 1 is held in a guide hole 74 formed in a punch 70 guided on the inner diameter 65 of the guide ring 61. In this state, a press ram, not shown, drives the punch 70 into the bonding member. When the punch 70 is driven into the bonding member, a ring-like bonding projection 76 presses a portion of the bottom portion 72 of a preliminarily bonding mark 71 in the vicinity of the bonding hole 21. The ring-like bonding projection 76 is disposed at the tip of the punch 70 and has a projection width W smaller than the projection width K of the preliminarily bonding projection 66 of the preliminarily bonding punch 60.

(0023)

The pressing force of the punch 70 is a load large enough to generate a stress for effecting a plastic deformation of the material forming the hub 2. The punch 70 is pressed down at the above-described load, and then, the material in the vicinity of the bonding hole 21 of the hub

2 is allowed to effect plastic-flow over the entire circumference of the groove 31, followed by the bonding. The bonded portion after the plastic-flow bonding in the above-described manner is shown in Fig. 10, which is an enlarged vertical cross-sectional view of the bonding.

(0024)

Furthermore, in order to achieve a high bonding accuracy, the smaller the gap between the guide hole 64 of the preliminarily bonding punch 60 or the guide hole 74 of the punch 70 and the outer peripheral surface of the shaft 1, the higher the bonding accuracy is obtained. Moreover, if the projecting width K and pressing depth J due to the preliminarily bonding projection 66 of the preliminarily bonding punch 60 are too large, the load for effecting the plastic deformation becomes large, thereby degrading the accuracy of the hub 2.

(0025)

Additionally, if the projecting width W and pressing depth H due to the bonding projection 76 of the punch 70 are too great, the load for the plastic deformation becomes large, and therefore, the material more than that flowing in the groove is liable to be fluidized, thereby degrading the bonding accuracy. Thus, the projecting width W and the pressing depth H are set according to the shape of the groove.

(0026)

Next, a description will be given below of the shape of the groove 31 of the shaft 1. Fig. 11 shows one example of the portion of the groove 31 of the shaft 1. Factors determining the cross-sectional shape of the groove 31 of the shaft 1 include the groove depth H, a groove width B, a groove angle θ, the number *n* of grooves and the like.

(0027)

If the depth H of the groove 31 of the shaft 1 is too small, a sufficient shearing strength cannot be achieved due to easy plastic deformation when external force is exerted in an axial direction. In contrast, if the depth H of the groove 31 of the shaft 1 is too large, the material insufficiently flows into the groove, thereby forming a gap, so as to degrade the strength. As shown in Fig. 7, the screw hole 67 for screwing the clamp 5 is formed at the lower portion of the shaft 1, and further, the female screw 32 is disposed at the inner wall surface of the screw hole 67 of the shaft 1. Consequently, the thickness at a portion near the bonded portion of the hub 2 to the lower portion of the shaft 1 becomes small. Therefore, if the depth H of the groove 31 of the shaft 1 shown in Fig. 11 is increased, the strength of the shaft 1 is degraded. Thus, the groove depth H of the groove 31 of the shaft 1 should desirably range from about 0.07 to about 0.13 mm.

(0028)

The width B of the groove 31 of the shaft 1 can be varied according to the shearing strength required at the bonded portion. However, if the width is set too largely, a distance from the tip of the punch 70 to the lower portion of the groove 31 of the shaft 1 becomes great in bonding to the hub 2, thereby increasing a fluid frictional loss of the material in the vicinity of the bonding hole 21 of the hub 2, which should flow into the groove 31 of the shaft 1. Therefore, even if the large load is applied to the hub 2 by the punch 70, the internal stress of the material in the vicinity of the bonding hole 21 of the hub 2 near the lower portion of the shaft 1 cannot be increased enough to achieve the plastic deformation. As a consequence, the material in the vicinity of the bonding hole 21 of the hub 2 near the lower portion of the shaft 1 is reduced in quantity of the plastic deformation, so that the material in the vicinity of the bonding hole 21 of the hub 2 insufficiently flows into the groove 31 of the shaft 1. In this manner, if the depth H of the groove 31 of the shaft 1 shown in Fig. 11 is increased, the strength of the shaft 1 is degraded. Thus, the depth H of the groove 31 of the shaft 1 should desirably range from about 0.07 to about 0.13 mm.

(0029)

Moreover, as shown in Fig. 11, as to the groove angle θ representing an opening degree (i.e., an angle) of the groove 31 of the shaft 1, if the opening angle θ of the groove 31 of the shaft 1 is small, the material in the vicinity of the bonding hole 21 of the hub 2 is less prone to flow into the groove 31 of the shaft 1 when the large load is applied to the hub 2 by the punch 70. In contrast, if the opening angle θ of the groove 31 of the shaft 1 is great, the material in the vicinity of the bonding hole 21 of the hub 2 shallowly bites when the large load is applied to the hub 2 by the punch 70, so that drawing strength becomes small. In this manner, if the groove angle θ of the groove 31 of the shaft 1 shown in Fig. 11 is small, the material is less prone to flow into the groove 31 of the shaft 1; in contrast, if the groove angle θ of the groove 31 of the shaft 1 is large, the drawing strength becomes small. As a result, the groove angle θ of the groove 31 of the shaft 1 should desirably range from about 60° to about 120°.

(0030)

Furthermore, as the number *n* of grooves 31 of the shaft 1 is greater, the contact area between the shaft 1 and the hub 2 becomes larger, thereby increasing the drawing strength. However, if the number *n* of grooves 31 of the shaft 1 is great, the material in the vicinity of the

bonding hole 21 of the hub 2 is less prone to flow into the groove 31 of the shaft 1 when the large load is applied to the hub 2 by the punch 70. As a consequence, if the number *n* of grooves 31 of the shaft 1 is too great, the drawing strength is much degraded. Thus, when the number *n* of grooves 31 of the shaft 1 is 2, the drawing strength is highest. Upon comparison of the case of n = 1 with the case of n = 2 under the condition that the groove width B is the same, the contact area between the shaft and the hub is greater in the case of n = 2, thereby increasing the drawing strength.

(0031)

Incidentally, the cross-sectional shape of the groove 31 of the shaft 1 need not be a triangle as shown in Fig. 11. It may be a round shape, as shown in Fig. 12. In the case where a high torque strength is needed at the bonded portion between the lower portion of the shaft 1 and the hub 2, a knurl 36 may be formed at a thread between the grooves 31 of the shaft 1, as shown in Fig. 13.

(0032)

Additionally, if the groove 31 of the shaft 1 is formed over the entire circumference of the shaft 1, the material in the vicinity of the bonding hole 21 of the hub 2 plastically flows over the entire circumference in a uniform manner when the large load is applied to the hub 2

by the punch 70, and further, strain also uniformly is exerted over the entire circumference, so that both of accuracy of a right angle and strength can be enhanced. In addition, the groove 31 of the shaft 1 can be molded by lathing, thus achieving high productivity.

(0033)

Furthermore, it is preferable that the position of the groove 31 of the shaft 1 should be set near a pressing surface 24 of the hub 2 as possible. If the position of the groove 31 of the shaft 1 is positioned apart from the pressing surface 24 of the hub 2, a fluid frictional resistance becomes high, and therefore, the material in the vicinity of the bonding hole 21 of the hub 2 is prone to flow into the groove 31 of the shaft 1.

(0034)

In view of this, in the present preferred embodiment, as shown in Fig. 14, the outer circumferential portion of the shaft 1 having the annular groove 31 formed at the outer periphery of the shaft 1 is freely fitted into the bonding hole 21 of the hub 2; the large load is applied to the hub 2 by the punch 70; the vicinity of the hole formed at the end surface of the hub 2 is plastically deformed over the entire circumference; the shaft 1 and the bonding hole 21 of the hub 2 are subjected to the preliminarily plastic bonding in such a manner as to fill the gap; the

material in the vicinity of the bonding hole 21 at the end surface is plastically deformed over the entire circumference after the preliminarily plastic bonding of the hub 2 in the state in which a stress s is exerted on the bonding hole 21 of the hub 2; a compression stress is exerted on the shaft 1 in such a manner as to fill the groove 31 of the shaft 1; and then, the material in the vicinity of the bonding hole 21 of the hub 2 is allowed to plastic-flow. The shearing force and strain P of the material in the vicinity of the bonding hole 21 of the hub 2 and the stress s caused by the preliminarily plastic bonding are exerted on a portion remote from the pressing portion, on which the strain is hardly exerted, as shown in Fig. 15. Thus, the connection strength between the hub 2 and the shaft 1 is high.

(0035)

Incidentally, the present invention is not limited to the above-described preferred embodiment, but it can be applied to bonding between other members of various kinds of metals, for example, a shaft, a cylinder or the like and a flat plate.

(0036)

According to the present invention, it is possible to achieve the sufficient strength and accuracy without any occurrence of bending or contamination even in the case of

the bonding between the thin hub and the small-diameter shaft.

(0037)

Moreover, the fitting accuracy before the bonding may be rough in comparison with the press-fitting, the high productivity can be achieved in inexpensive equipment, and further, the fabricating cost can be reduced.

Brief Description of the Drawings;

Fig. 1 is a general plane view of a hard disk drive to which the present invention is applied.

Fig. 2 is a vertical cross-sectional view of the hard disk drive shown in Fig. 1.

Fig. 3 is an enlarged cross-sectional view of a dynamic pressure bearing spindle motor, using a bonded body of a hub and a shaft, in the hard disk drive shown in Fig. 2.

Fig. 4 is a vertical cross-sectional view of the bonded body of the hub and the shaft.

Fig. 5 is a side view of the shaft.

Fig. 6 is a vertical cross-sectional view of the hub.

Fig. 7 is a vertical cross-sectional view of a molding die used in a process of preliminarily plastic bonding.

Fig. 8 is an enlarged vertical cross-sectional view of a bonded portion of the shaft and the hub after completion of the preliminarily plastic bonding.

Fig. 9 is a vertical cross-sectional view of a molding die used in a process of plastic-flow bonding.

Fig. 10 is an enlarged vertical cross-sectional view of the bonded portion of the shaft and the hub after the completion of the plastic-flow bonding.

Fig. 11 is an enlarged vertical cross-sectional view of a groove of the shaft.

Fig. 12 is an enlarged vertical cross-sectional view of a round groove of the shaft.

Fig. 13 is an enlarged view showing a groove having a knurl at the shaft.

Fig. 14 is an enlarged vertical cross-sectional view of the bonded portion of the shaft and the hub, representing a stress after the completion of the preliminarily plastic bonding.

Fig. 15 is an enlarged vertical cross-sectional view of the bonded portion of the shaft and the hub, representing a stress after the completion of the plastic bonding.

(Explanation of reference numerals)

1 ---shaft

2 ---hub

3 ---disc

12 ---cylindrical portion

21 ---bonding hole

31 ---groove

60 ---preliminary bonding punch

66 --- preliminary bonding projection

71 ---preliminary bonding mark

70 ---punch

76 ---bonding projection

80 ---preliminary bonded body

200 ---hard disc drive device

(Document name) Abstract

(Summary)

(Object) To provide a plastic flow bonding methd at a low cost, with a high bonding strength, high precision, and no contamination.

(Means for achieving the object) A method of bonding a bonding member and a member to be bonded used in a rotating device 200, wherein a rotating disc as the bonding member 2 and the rotating shaft as the member 1 to be bonded. The method comprises a first step for preliminary plastic bonding by means of a preliminary bonding punch wherein the bonding member 2 s fitted to the member 1 to be bonded; a second step, after the plastic bonding in the first step, for plastic bonding by filing part of material of the bonding member into a gap between the bonding member 2 and the member 1 to be bonded wherein a compression force is

generated in the axial direction of the member to be bonded in the vicinity of the fitted portion of the bonding member and the member to be bonded, thereby to integrate the member 2 and member 1.